CLAIMS

1. Laminate comprising a monofilm-formed or multifilm-formed ply (A) and another monofilm-formed or multifilm-formed ply (B) both mainly consisting of orientable thermoplastic polymer material, in which A has a fluted configuration and B on a first side is adhesively bonded in bonding zones to the crests on a first side of A, characterised in that

a) B also has a fluted configuration, the flute direction of B forming an angle from generally about 30° up to and including 90° to the flute direction of A and the said bonding zones being on the crests of the first side of B to produce spot bonding with the crests on the first side of A,

b) the adhesive bonding is

i) directly A to B and established through a lamination layer on A and/or B;

ii) established through a separate thin bonding film; or

iii) through a fibrous web adapted for bonding, and

c) the wavelengths of the flutes in A and/or B are no longer than 5 mm, and the wavelengths of the flutes in both A and B are less than 10 mm.

2. Laminate according to claim 1, characterised in that either the thickness of each of the said plies is generally the same in bonded and unbonded zones, or at least one of the plies exhibits first solid-state-attenuated zones extending parallel to the flute direction, each bonding zone mainly being located within such a first attenuated zone whereby each first attenuated zone is understood as delimited by the positions where the thickness is an average between the minimum thickness of this ply within the first attenuated zone and the ply's maximum thickness within the adjacent non-bonded zone.

3. Laminate according to claim 1 or 2 characterised in that the flute wavelength in each of the two plies is no more than 4 mm, preferably no more than 3 mm and still more preferably no more than 2 mm.

4. Laminate according to any of the preceding claims characterised in that in each of the two plies the curved length of a flute is on

average at least 5% and preferably at least 10% longer than the linear wavelength, the curved length being understood as the length of a curve through the cross section of a full flute wave including the bonding zone which curve lies in the middle between the two surfaces of the ply.

5. Laminate according to claim 4, characterised in that in at least one of said plies the said average is at least 15%.

6. Laminate according to any of the preceding claims, characterised in that the width of each bonding zone in at least one of the two plies is no less than 15%, preferably no less than 20%, and still more preferably no less than 30% of the flute wavelength.

7. Laminate according to any of the preceding claims, characterised in that the flutes in at least one of the two plies are evenly formed and extend in a generally rectilinear shape.

8. Laminate according to any of the preceding claims, characterised in that the flutes in at least one of the two plies while extending mainly along one direction, are curved or zig-zagging and/or branched.

9. Laminate according to any of the preceding claims, characterised in that the flutes in at least one of the two plies while extending mainly along one direction are differently shaped in a pattern which gives a visual effect showing a name, text, logo or similar.

10. Laminate according to any of the preceding claims, characterised in that at least one of the two plies has a metallic or iridescent gloss, or the two plies have different colours.

11. Laminate according to any of the preceding claims, characterised in that the main direction in which the flutes of A extend is generally substantially perpendicular to the main direction in which the flutes of B extend.

12. Laminate according to claim 11, characterised in that one of the said two directions essentially coincide with the machine direction of the lamination.

13. Laminate according to any of the preceding claims, <u>characterised in that</u> A, outside its first attenuated zones if such zones are present, is molecularly oriented mainly in a direction parallel to the direction of its flutes or in a direction close to the latter as determined by shrinkage tests.

14. Laminate according to claim 13, <u>characterised in that</u> B also is molecularly oriented and B's orientation outside its first attenuated zones if such zones are present is higher than A's average orientation in the same direction outside its first attenuated zones if such zones are present, the said two orientations being observable by shrinkage tests.

15. Laminate according to claims 13 or 14, <u>characterised in that</u> the yield tension in A in a direction parallel with its flutes and/or the yield tension in B in a direction parallel with its flutes, both referring to the cross-section of the respective ply and determined in non-bonded narrow strips at an extension velocity of 500% min^{-1}, is no less than 30 MPa, preferably no less than 50 MPa and still more preferably no less than 75 MPa.

16. Laminate according to any of the preceding claims, <u>characterised in that</u> B has a lower coefficient of elasticity than A, both as measured in the direction perpendicular to the flute direction of A.

17. Laminate according to claim 13, <u>characterised in that</u> the choice of material for B and of depth of A's fluting is such that by stretching of the laminate perpendicular to the direction of A's fluting up to the point where A's waving has disappeared, B still has not undergone any significant plastic deformation, preferably B comprises a thermoplastic elastomer.

18. Laminate according to claim 13, 14 or 15, <u>characterised in that</u> B, outside its first attenuated zones if such zones are present, has a main direction of molecular orientation parallel to the direction of the flutes or in a direction close to the latter as provable by shrinkage tests.

19. Laminate according to claim 13, <u>characterised in that</u> A is composed of several films, and the said main direction of molecular

orientation, is the resultant of different monoaxial or biaxial orientations in the said films optionally mutually differently directed.

20. Laminate according to claim 18, characterised in that B is composed of several films, and the said main direction of orientation is the resultant of different monoaxial or biaxial orientations in the said films optionally mutually differently directed.

21. Laminate according to any of the preceding claims in which first attenuated zones are present in at least one of the two plies characterised in that if such zones of attenuated ply extend in their transverse direction beyond the corresponding zones of bonding into non-bonded zones of the ply, the extensions within each non-bonded zone are limited to a total width which leaves more than half of and preferably no less than 70% of the width of the non-bonded zone as not belonging to any first attenuated zone, these widths being the distances measured along the curved surfaces.

22. Laminate according to any of claims 1 to 20 in which first attenuated zones are present in at least one of the plies and in which the bonding zones are generally coincident with the first attenuated zones.

23. Laminate according to any of the preceding claims in which first attenuated zones are present at least in one of the two plies characterised by a second solid-state-attenuated zone between each pair of adjacent first attenuated zones, said second attenuated zones being narrower than said first attenuated zones and located on the non-bonded crests of the respectively ply.

24. Laminate according to any of the preceding claims, in which at least one of the two plies exhibits solid-state-attenuated zones characterised in that the first attenuated zones of the ply are attenuated so that the minimum thickness in such zone is less than 75% of the maximum thickness of the ply in the non-bonded zone, preferably less than 50% and more preferably less than 30% of that maximum thickness.

25. Laminate according to any of the preceding claims, <u>characterised in that</u> A and B consist of material which is orientable at room temperature, preferably they mainly consist of polyolefin.

26. Laminate according to any of the preceding claims, <u>characterised in that</u> the spot-bonding between plies A and B is effected through a lower melting surface layer on at least one of the plies, formed in a coextrusion process.

27. Laminate according to any of the preceding claims, <u>characterised in that</u> at least one of the plies comprises a barrier film, e.g. for protection against oxygen or other gaseous materials.

28. Laminate according to any of the preceding claims, <u>characterised in that</u> at least some of the flutes in one or both plies are flattened at intervals and preferably bonded across each ones entire width at the flattened locations to make the two arrays of flutes form closed pockets.

29. Laminate according to claim 28, <u>characterised in that</u> the flattened portions of a number of mutually adjacent flutes or of all flutes are in array.

30. Laminate according to any of claims 1 to 23 <u>characterised in that</u> by the choice of polymer material or by an incorporated filler or by orientation, the coefficient of elasticity E in at least one of the plies, measured in the unbonded zone of the ply in the direction parallel to the flute, as an average over the unbonded zone is no less than 700 MPa, and preferably no less than 1000 MPa.

31. Laminate according to any of the preceding claims, <u>characterised in that</u> at least some of the channels formed by the flutes in A and B, which channels may be closed to pockets, contain a filling material in particulate, fibrous, filament or liquid form.

32. Laminate according to claim 31, <u>characterised in that</u> said material is a preservative for goods intended to become packed in or protected by the laminate, preferably an oxygen scavenger or ethylene scavenger, a biocide, such as a fungicide or bactericide, a corrosion inhibitor

or a fire extinguishing agent, optionally with micro-perforations established in the flutes to enhance the effect of said preservative.

33. Laminate according to any of the preceding claims, characterised in that both A and B are supplied with a multitude of perforations, whereby the perforations do not reach into the bonded spots, and the perforations in A are displaced from the perforations in B so as to cause gas or liquid when passing through the laminate, to run a distance through the flutes generally parallel to the main surfaces of the laminate; the channels formed by the flutes may be closed to form pockets.

34. Laminate according to claim 33, characterised in that the channels or pockets contain filling material adapted to act as a filter material by holding back suspended particles from a fluid passing through the channels or pockets or is an absorbent or ion-exchanger capable of absorbing or ion-exchanging matter dissolved in such fluid, said filler optionally being fibre-formed or yarn-formed.

35. Laminate according to claim 34, in which by choice of hydrophobic properties of at least the inner surfaces of the channels or pockets formed by the flutes and by selected small spacing of said channels or pockets, and choice of the distances between the mutually displaced perforations in A and B, there is achieved a desirable balance between the pressure needed to allow water through the laminate and the laminate's capability to allow air and vapour to pass therethrough.

36. Laminate according to claim 33, characterised by a nap of fibre-like film portions protruding from the borders of the perforations of at least on one surface of the laminate.

37. Laminate according to claim 35 or 36, used as a sanitary backsheet, preferably on a diaper or as a sheet for covering a patient during surgery.

38. Laminate according to claim 35 or 36, used for insulation of buildings.

39. Laminate according to claim 33 or 34 used as a geotextile which allows water to pass but holds fine particles back.

40. A bag made from the laminate according to any of the claims 1 to 33, <u>characterised in that</u> the flutes on one of the two major surfaces of the bag are generally perpendicular to the flutes on the other major surface of the bag.

41. Method of manufacturing a laminate of a first monofilm-formed or multifilm-formed ply with a second monofilm-formed or multifilm-formed ply both mainly consisting of orientable thermoplastic polymer material, in which the first ply has a waved flute configuration, and the second ply on a first side is adhesively bonded in bonding zones to the crests on a first side of A, in which further the waved flute structure of the first ply is formed by the use of a grooved roller, and the said bonding with the second ply is carried out under heat and pressure and also under use of a grooved roller,
<u>characterised in that</u>

a) the second ply also is given a waved configuration, whereby under use of at least one grooved roller the flute direction of the second ply is made at an angle to the flute direction of the first ply and the said bonding zones are established on the crests of the first side of the second ply to introduce spot bonding with the crests on the first side of the first ply,

b) the adhesive bonding

i) is directly first to second ply and established through a lamination layer on at least one of these plies;

ii) established through a separate thin bonding film; or

iii) established through a fibrous web adapted to the bonding; and

c) the wavelengths of the flutes in both plies are no longer than 10 mm, and the wavelengths of the flutes in at least one of the plies are no longer than 5 mm.

42. Method according to claim 41, <u>characterised in that</u> the films constituting at least one of the two plies are made by coextrusion in which

there is coextruded a lower melting surface layer to enable the lamination without any melting of the main body of the plies.

43. Method according to claim 41 or 42, characterised in that the two plies consist of material which is orientable at room temperature, preferably they mainly consist of polyolefin.

44. Method according to any of claims 41 to 43 characterised in that prior to the said bonding process at least one of said plies is solid-state stretched in narrow zones to form first attenuated zones which are parallel to the selected direction of fluting in the ply, said stretching being generally perpendicular to the said direction and carried out between a set of grooved rollers both different from the grooved roller for lamination, and that the grooved roller for lamination is coordinated with the said set of grooved rollers for stretching in such a way that each zone of bonding mainly becomes located within a first attenuated zone.

45. Method according to claim 44, characterised in that prior to or after the formation of the first attenuated zones, another set of grooved rollers produces second attenuated zones which are another series of solid-state oriented narrow zones in the same ply, parallel with the first attenuated zones and narrower than the latter, while the grooved rollers which produce said second attenuated zone are coordinated with the grooved rollers which produce the first attenuated zones so that each second attenuated zone becomes located generally in the middle between two neighbouring first attenuated zones.

46. Method according to claim 44 in which the lamination layer is heated to the lamination temperature by heating from the opposite side of the ply, and in which the temperature of the laminating roller and the thickness of the film in the first attenuated zones is such as to allow the laminating layer to reach said lamination temperature whilst the thickness of the ply outside the attenuated zone which is in contact with the crests of the grooved lamination roller is such that the lamination layer outside the

attenuated zone does not reach said lamination temperature, where the first attenuated zones and the bonding zones become generally coincident.

47. Method according to any of claims 41 to 46, characterised in that the pitch of the grooved roller which produces the lamination on the crests is at the highest 3,0 mm, preferably no more than 2,0 mm and still more preferably no more than 1,5 mm.

48. Method according to any of claims 41 to 47, characterised in that prior to the forming of the waved flute structure and if the methods of claims 44 to 46 are used, also prior to the formation of the attenuated zones, the film or films constituting at least one of the plies are supplied with orientation in one or both directions, the resultant main direction of orientation in such ply being essentially in the direction which is selected to become its direction of fluting.

49. Method according to any of claims 41 to 48, characterised in that at least a part of the depth of each flute in at least one of the two plies, is carried out after the lamination by thermal shrinkage of the other ply in a direction essentially perpendicular to the predetermined direction of such flutes.

50. Method according to claim 44, characterised in that a suitably distinct stripe formation of the first attenuated zone is established at least in part by giving the crests on the grooved stretching roller intended to produce the stripes a temperature which is higher than the temperature on the crests on the other grooved stretching roller and/or by giving the crests on the grooved stretching roller intended to produce the stripes a radius of curvature which is smaller than the radius of curvature of the crests on the matching grooved stretching roller.

51. Method according to any of claims 41 to 50, characterised in that the flute structure in one of the plies is established essentially in the machine direction under a generally transverse orientation process by taking the ply before lamination through a set of driven mutually intermeshing

grooved rollers, the grooves on the rollers being circular or helical and forming an angle of at least 60° with the roller axis.

52. Method according to claim 51, characterised in that this ply is passed directly from its exit from the last of the grooved stretching and fluting rollers to the grooved lamination roller, these two grooved rollers being in close proximity to each other and having the same pitch when measured at each ones operational temperature and being mutually adjusted in the axial direction for alignment of the grooves.

53. Method according to claim 51, characterised in that this ply is passed from its exit from the last of the grooved and fluting rollers to the grooved lamination roller over one or a series of heated, grooved transfer rollers, the grooved rollers in the row starting with the grooved stretching rollers and ending with the grooved lamination roller each being in close proximity to its neighbour or neighbours, whereby each of the grooved rollers in the row has the same pitch when measured at their respective operational temperature, and being mutually adjusted in the axial direction for alignment of the grooves.

54. Method according to any of claims 41 to 50, characterised in that each grooved roller used to form the flutes in one of the plies and each grooved roller used to form the first attenuated zones in this ply according to claim 44 if such zones are produced, and each grooved roller used to form the second attenuated zones according to claim 45 if such zones are formed in this ply and a grooved roller which the ply follows before and during the lamination if such roller is used, are rollers in which the grooves are essentially parallel with the roller axis, and means are provided to hold the flutes of the said ply in the respective grooves during the passage from the position where the flutes are formed to the position where lamination takes place, said holding means adapted to avoid a frictional rubbing on the ply during said passage.

55. Method according to claim 54, characterised in that the flutes in this ply are formed by use of an air jet or a transverse row of air jets which directs A into the grooves on the forming roller.

56. Method according to any of claims 54 or 55, characterised in that first attenuated zones are formed accordingly to claim 44 by grooved rollers acting in coordination with the grooved roller used for lamination, and said coordination consists in an automatic fine regulation of the relative velocities between the rollers.

57. Method according to claim 56, characterised in that said second attenuated zones are formed according to claim 45 by grooved rollers acting in coordination with the grooved rollers used to produce the first attenuated zones, and said coordination consists in an automatic fine regulation, of the relative velocities between the rollers.

58. Method according to any of claims 41 to 57, characterised in that after the lamination at least some of the flutes in each ply are flattened in locations placed at intervals, preferably under heat and pressure sufficient to bond the plies to each other in said locations so that the two arrays of flutes together form closed pockets.

59. Method according to claim 58, characterised in that at least some of the flattening is carried out with bars or cogs which have their longitudinal direction arranged generally in the machine direction and/or the direction transverse to this.

60. Method according to any of claims 41 to 59, characterised in that particulate, liquid or fibre-or yarn-formed material is filled into some at least of the channels formed by the two arrays of flutes, this filling taking place prior to or during the lamination.

61. Method according to claim 60, characterised in that after filling the filled channels are closed at intervals by pressure and heat to form filled pockets.

62. Method according to claim 60 or claim 61, characterised in that prior to, simultaneously with or following the filling step perforations are

made in the laminate at least on one side to help the filling material or part thereof dissipate into the surroundings or to allow air or liquid to pass through the filling material.

63. Method according to any of claims 41 to 62, characterised in that there is made a multitude of perforations in the first and in the second ply, but limited to areas, where the two plies are not bonded together, and the perforations in the first ply being displaced from the perforations in the second ply to force air or liquid which passes through the laminate to run a distance along one or more channels.

64. Method according to any of claims 41 to 63, characterised in that in one process step there is melted a multitude of holes in the first but not in the second ply or in the second but not in the first ply, these holes being formed by contacting flutes of the first ply with protruding surface parts of a hot roller, which are moved at essentially the same velocity as the laminate.

65. Method according to claim 64, characterised in that the holes are formed by contacting flutes of the second ply with protruding preferably sharp, surface parts of a hot roller, which are moved at essentially the same velocity as the laminate, while heat insulating material prevents the flutes from contacting the hot surfaces of the roller, and preferably the laminate is pressed towards the protruding parts by means of air jets.

66. Method according to claim 64 or claim 65, characterised in that there is drawn a protruding nap of fibre-like film portions out from the molten surroundings of the holes by blowing air in between the laminate and the hot roller, where the laminate leaves the roller.

67. A method of manufacturing a laminate of a first ply with a second ply both mainly consisting of orientable thermoplastic polymer material and each having one face comprising a lamination layer in which the first and second plies are continuously fed in face to face relationship with the lamination layers in direct contact with one another between a pair of laminating rollers between which heat and pressure is applied, whereby

the lamination layers become adhered to one another, in which the second ply is oriented mainly transversely of the machine direction, and is generally not shrinkable in solid state in the direction transverse to its orientation, and the first ply as it is fed to the lamination rollers is heat-shrinkable mainly in a shrink direction which is generally parallel with the machine direction, the lamination rollers apply heat and pressure in bonding zones arranged in continuous or discontinuous rectilinear lines extending in a direction which is generally perpendicular to said shrink direction, and after lamination the first ply is caused to shrink in solid or semisolid state in the said shrink direction, whereby the second ply becomes fluted with flutes extending perpendicular to said shrink direction and having a wavelength at the highest about 5 mm.

68. A method of manufacturing a laminate of a first ply with a second ply both mainly consisting of orientable thermoplastic polymer material and each having one face comprising a lamination layer in which the first and second plies are continuously fed in face to face relationship with the lamination layers in direct contact with one another between a set of laminating devices between which heat and pressure is applied, whereby the lamination layers become adhered to one another, in which the second ply is oriented mainly transversely of the machine direction, and is generally not shrinkable in solid state in the direction transverse to its orientation, and is prior to the lamination rollers, segmentally stretched in its machine direction to introduce first attenuated zones perpendicular to the machine direction, the first ply as it is fed to the lamination rollers is heat-shrinkable mainly in a shrink direction which is generally parallel with the machine direction, the laminating devices comprise on the side facing the second ply a heated flat roller or a heated porous bar adapted to produce a film of hot air to press the plies towards the opposite laminating device, which may be either a roller or a similar bar, the speed of the machine and the temperatures of the rollers being adapted to heat the lamination layer in said first attenuated zones to the lamination temperature, but not to heat the lamination layer in the adjacent non-attenuated zones to the lamination temperature, whereby

bonding takes place only in the attenuated zones, and after lamination the first ply is caused to shrink in solid or semisolid state in the said shrink direction, whereby the second ply becomes fluted with flutes extending perpendicular to said shrink direction and having a wavelength at the highest about 5 mm.

69. A method according to claim 67 or claim 68 in which said wavelength is at the highest about 3 mm.

70. A method according to any of claims 67 to 69, in which the first ply is kept substantially flat throughout the manufacturing process.

71. A method according to claim 67, in which the first ply is supplied with waves prior to the lamination, the wavelength being at the highest about 5 mm, preferably at the highest about 3 mm, and the lamination zones are on the crests on one side of the waved first ply.

72. A method according to any of claims 67 to 71 characterised in that, by use of a take-off roller (13) of slightly waved surface, the laminate on its whole is supplied with a longitudinal waving to eliminate a tendency to curling around its transverse direction.

73. A method according to claim 67 in which said rectilinear lines are discontinuous and in which the discontinuities in adjacent lines are aligned in the shrink direction.

74. Laminating apparatus comprising a grooved roller for fluting a first ply of thermoplastic polymer material, a grooved roller for fluting a second ply of thermoplastic polymer material, means for directing the first and second plies from their respective grooved rollers to a laminating station with the plies arranged in face to face contact with one another and with the flutes of the first ply generally directed at an angle to the flutes of the second ply, the laminating station comprising grooved laminating rollers which apply heat and pressure between the plies to bond the plies together at the crests of the flutes of the second ply to form a laminate, the grooved fluting rollers and the grooved laminating rollers having groove pitches such that in the

laminate the plies each have flutes of wavelength less than 10 mm and the flutes of at least one of the plies have a wavelength no longer than 5 mm.

75. Apparatus according to claim 74 comprising a first set of grooved stretching rollers upstream from the laminating station for at least one of the plies, which stretches the material of the respective ply in a solid state and in a direction generally perpendicular to the flutes to form first attenuated zones, wherein the grooved stretching rollers, grooved fluting rollers and grooved laminating rollers are coordinated so that the first attenuated zones become the crests of the flutes and the bonding zones are mainly located within first attenuated zones.

76. Apparatus according to claim 75 comprising, between the said grooved stretching rollers and the laminating station, a second set of grooved stretching rollers, which stretches the material of the said respectively in a solid state and in a direction generally perpendicular to the flutes to form second attenuated zones extending parallel to and between said first attenuated zones which are narrower than said first attenuated zones, whereby the second attenuated zones become the troughs of the flutes.

77. Apparatus according to claim 75 or 76 in which the crests of the grooves of the laminating roller are wider than the first attenuated zone and in which the side of the ply opposite to the face in contact with the other ply is heated in the lamination station, preferably by supplying heat to the interior of the grooved laminating roller.

78. Apparatus according to any of claims 74 to 77 in which the grooves in the rollers are formed such that the flutes in the two plies are generally mutually perpendicular, preferably the flutes in the first ply being substantially parallel to the machine direction.

79. Apparatus according to claim 78 comprising, upstream of the fluting rollers, for at least one of the plies, an orienting station for providing the ply with uniaxial or unbalanced biaxial orientation with the main direction of orientation being generally parallel to the flute direction.

80. Apparatus according to of claim 75 in which the grooved stretching rollers consist of a set of driven mutually intermeshing grooved rollers, the grooves on the rollers being circular or helical and forming an angle of at least 60° with the respective roller axis.

81. Apparatus according to claim 80 in which the last of the grooved stretching rollers is in close proximity to the grooved laminating roller and the grooves of each are of the same pitch at the operating temperature of the apparatus and being aligned.

82. Apparatus according to claim 80 which comprises one or a series of heated grooved transfer rollers located between the last of the grooved stretching rollers and the grooved laminating roller, adjacent rollers being close together, the grooves of the stretching, transfer and laminating rollers having the same pitch at the operating temperature of the apparatus and being aligned with one another.

83. Apparatus according to any of claims 74 to 82 in which the grooved fluting roller for one of the plies has the grooves arranged substantially parallel with the roller axis and in which substantially frictionless holding means are provided for holding the flutes of the respective ply in the grooves.

84. Apparatus according to claim 83 in which the frictionless holding means comprises air pressure difference between opposite sides of the ply at the groove.

85. Apparatus according to any of claims 74 to 84 in which downstream of the grooved laminating roller in the lamination station there is a flute flattening station in which at least some of the flutes in each ply are flattened and the plies bonded to one another under heat and pressure to form closed pockets.

86. Apparatus according to claim 85 in which the flute flattening station comprises bars and/or cogs extending generally in the machine direction or the cross-direction and counter rollers, bars or cogs against which to bear.

87. Apparatus according to any of claims 74 to 86 comprising flute filling means for filling the flutes of one or both plies before or during the lamination station with particulate, fibre or liquid material.

88. Apparatus according to any of claims 74 to 87 comprising perforating means for cutting or melting holes into the flutes of one or both plies in non-bonded zones.

89. Apparatus according to claim 88 in which the perforating means comprise a driven perforating roller having an arrangement of heated protrusions which contact and melt the material in the flutes of the respective ply.

90. Apparatus according to claim 89 further comprising pressurised air outlets for directing air at the ply while the material surrounding the perforations is molten.

91. Apparatus according to claim 89 or 90 in which the flutes of the ply are directed into contact with said protrusions by air jets directed at the surface of the ply opposite to the perforating roller.

92. Laminating apparatus comprising a grooved roller for fluting a first ply of heat-shrinkable thermoplastic polymer material having a main shrink direction parallel to the flute direction, means for continuously directing the fluted first ply and a second ply of thermoplastic material in face-to-face relationship to a laminating station, the laminating station comprising laminating rollers between which heat and pressure is applied in laminating zones between the crests of the flutes of the fluted first ply and the second ply whereby bonding zones are formed extending in continuous or discontinuous rectilinear lines along the crests of the flutes at which the plies are bonded to one another, the apparatus further comprising a heat shrink station in which the first ply in the bonded product is heated to its heat shrink temperature and allowed to shrink, the bonding zones being adapted to allow the second ply to become fluted upon shrinkage of the first ply, the wavelength of the fluting being less than 5 mm.

93. Apparatus according to claim 92 in which the second ply is fed to the laminating station as a substantially planar web.

94. Apparatus according to claim 92 or 93 in which the laminating station comprises a pair of grooved rollers, between which the heat and pressure is applied for lamination, the grooves of the laminating roller in contact with the first ply being parallel to and under operating conditions, having the same pitch as the grooves of the fluting roller for the first ply, and the grooves of the laminating roller in contact with the second ply being arranged at an angle, preferably substantially perpendicular to these grooves.

95. Apparatus according to claim 92 or 93 in which the laminating station comprises a grooved laminating roller and a substantially smooth counter roller between which the heat and pressure is applied for lamination with the grooved laminating roller in contact with the first ply; the grooves of the grooved laminating roller being parallel to and, under operating conditions, having the same pitch as the grooves of the fluting roller for the first ply.

96. Apparatus according to claim 95 which comprises a stretching station for the second ply at which the second ply is segmentally stretched in solid state to produce first attenuated zones extending in a direction at an angle to the direction of the flutes of the first ply, preferably perpendicularly thereto, wherein the substantially smooth laminating roller is heated to a temperature which heats the opposite surface of the second ply in the first attenuated zones to the laminating temperature while the adjacent areas do not reach that temperature.

97. Apparatus according to any of claims 74 to 96 in which the land on the crest of the or each grooved laminating roller is at least 15%, preferably at least 20%, more preferably at least 30% of the pitch of the grooved of that roller.

98. Laminating apparatus comprising a grooved roller for fluting a first ply of thermoplastic polymer material, a grooved roller for fluting a

second ply of thermoplastic polymer material, means for directing the first and second plies from their respective grooved rollers between a set of laminating devices with the plies arranged in face to face contact with one another and with the flutes of the first ply generally directed at an angle to the flutes of the second ply, the set of laminating devices, comprising, on the side facing the second ply, a heated porous bar and on the side facing the first ply, an opposite laminating device, wherein said porous bar is adapted to produce a film of hot air to press the plies towards the opposite laminating device and bond the plies together at the crests of the flutes of the second ply to form a laminate, and the opposite laminating device is a roller or a porous bar, the grooved fluting rollers having groove pitches such that in the laminate the plies each have flutes of wavelength less than 10 mm and the flutes of at least one of the plies have a wavelength no longer than 5 mm.

99. Apparatus according to any of claims 74 to 98 in which the pitch of any grooved roller is no more than 4 mm, preferably no more than 3 mm, more preferably no more than 2 mm.